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MAGNETIC AND ELECTRIC FIELDS, IN THE 400 KILOVOLT ELECTRICITY TRANSMISSION LINES, THE IMPACT ON THE ENVIRONMENT

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Abstract: In the electricity transmission system in Albania, lines with voltage levels of 110 kV, 220 kV, and 400 kV are the lines that are used, compared to transmission lines with other voltage levels that are applied in other countries. These lines have an importance. very special in the transmission of electricity, as they supply electricity to cities and industry in the country, and some of them enable the exchange of electricity with neighboring countries, making the Albanian electricity system part of the European system. As a result, these lines have an extension almost throughout the territory of Albania. With the demographic movements in our country, mainly after the 90s, the demand for housing and for various businesses in urban areas increased, where the perspective promised security for the future. In many cases, these houses and businesses are also built in areas where high voltage lines pass, not taking into account the degree of danger of the electromagnetic field that can appear from these lines, which will be the focus of this study.

Keywords and phrases: High voltage, biological effects, distribution lines, electric field, electrodynamics.

MSC 2010 Classifications: Primary 78A25; Secondary 62P30.

1 Introduction

In the view of an electrical engineer, the areas where these lines pass are considered areas polluted by the electric and magnetic fields created by these lines. Considering the human body as a conductive material, then it becomes necessary to study the relationship between the magnetic field and the human body as well as the phenomena that develop in the latter when it is exposed to the fields in question for a long time [1]. It is more important to study if a person exposed to these fields, for a long time, shows biological problems different from normal ones, as well as for what value of the electromagnetic field these problems arise and which are the most delicate age groups [2].To deny the interaction between electromagnetic fields and living beings would be scientific nonsense. Like living beings, people are also open biological systems, by which we mean that: from the environment that surrounds them, near or far from them, they receive rhythmic information that acts in their internal environments [4]. So, with this we will understand that a living being, taking into consideration the human body can be considered globally as an ensemble of the interaction of electrical processes with biological organisms [5]. “quoted”

Electromagnetic waves that are present in the biosphere, whether natural or artificial, can positively or negatively affect the human body. For this matter, a study by the WHO (world health organization) has been published, which points out: ***“biological effects of electromagnetic waves that are sometimes but not always accompanied by harmful effects for health”.*** Regarding the harmful effects that electromagnetic waves bring to biological organisms, there are also some hypotheses that have not yet been scientifically proven, but have a high degree of compatibility with reality [6]. Considering that every living being reacts to a certain level of electric and magnetic fields, the object of this study will focus on the levels of these fields for 400 kilovolt electricity transmission lines [7].

2 Rates Above Recommended Levels

Every country, as well as in our country, some norms have been recommended, which until now are accepted as harmless for the human body [8]. These rates for Albania vary as follows:

For employees of the electric power system

a) Working day (8 hours): Electric field 10 kV/m Magnetic field 500 micro tesla
b) A few hours a day: Electric field 30 kV/m Magnetic field 5000 micro tesla

For the population

a) 24 hours a day: Electric field 5 kV/m Magnetic field 100 micro tesla
b) A few hours a day: Electric field 10 kV/m Magnetic field 1000 micro tesla

In this study, we will consider only the case when the population is exposed to the fields in question for 24 hours a day. The positions in which the electric and magnetic field will be studied are the places near the pole and between the camp of the lines. For each line, the types of poles used in these lines were taken and the height of the conductors from the ground as well as from the axis of the pole were determined [9].

As for the height of the conduits from the ground in the middle of the camp, they vary depending on the area they pass through. We have three areas, the classification of which is as below:

Table 1. The rates recommended and accepted in Albania for each of the above-mentioned areas.

Distribution Lines	Unresidential Lines	Road Areas	Residential Areas
110 kV Lines	6m	7m	7m
220 kV Lines	7m	8m	8m
400 kV Lines	8m	10m	9m

The lines with a voltage level of 400 kV in Albania are Elbasan 2 — Zemblak; Zemblak — Kardia; Tirana 2 — Elbasan 2; Tirana 2 — Vau i Dejes; Vau i Dejes — Kosovo; Vau i Dejes — Podgorice (Montenegro).

In the study, we analyze the line, Tirana 2 - Vau i Dejes, which passes over uninhabited areas, over roads and in inhabited areas (Fig.1). Calculations for the electric and magnetic field at the pole as well as in the middle of the camp were performed for each phase [10]. The graphs of the respective fields were built with the values found. The values found refer to the height of one meter from the ground surface. In the presented article, we will focus in detail on the study and analysis of the line, Tirana 2 - Vau i Dejes with a length of 76.13 km.

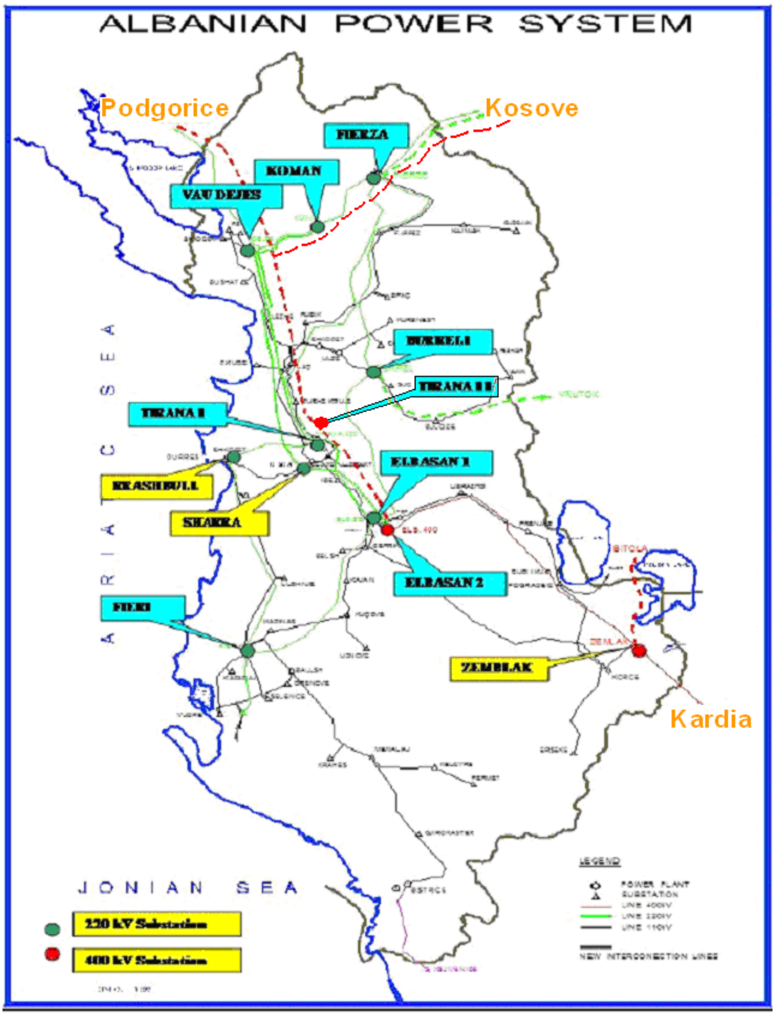


Figure 1. Map of the Albanian Electricity System

3 Calculation Program, Data, & Main Concept

The calculation program has as a starting point the corresponding calculation formulas presented below, respectively for the electric field and for the magnetic field [11].

$$E_y\left(\frac{kV}{m}\right) = k_1 U\left[A - \frac{1}{2}(B+C) + j\frac{\sqrt{3}}{2}(B-C)\right],$$

$$B_x(T) = k_2 I\left[A - \frac{1}{2}(B+C) + j\frac{\sqrt{3}}{2}(B-C)\right].$$

It is noted that the analysis is done in the plane of complex numbers in their algebraic form. The main task of the calculation program is to algebraically superimpose the electric and magnetic field of the line presented with the complex functions above, operating with their real and imaginary parts and pass the result to the calculation of the corresponding absolute values, which are the values of the electric field and magnetic [12].

More specifically, in the algebraic form we would have: $\alpha_1(x)+j\alpha_2(x)$; $\alpha_1(x)+j\alpha_2(x)$. The task of the program is to add algebraically and arrive at the resultant $\alpha_1(x)+\alpha_2(x)$, where $\alpha_1(x)$ is the summation of $\alpha_1(x)$ AND $\alpha_2(x) = \Sigma\alpha_2(x)$. Next is the task of building the modules, $A(x) = \sqrt{\alpha_1^2 + \alpha_2^2 + \ldots}$. This is done for the expression of $E(x)$ and for the expression of $B(x)$ in the same way. So the program gives us these resultant values in complex form and as a module. He even took on the task of graphically presenting the values of E and B depending on the distance x [13].

The program gives the possibility that by treating it in the complex plan, the superposition of two fields can be done, as is the case of lines with two circles.

There is even a possibility that this program will be adopted for the line with four districts. This is a special engineering opportunity.

The data entered into the program are [14]:

a) Nominal line voltage.
b) Nominal line current.
c) The height of living things from the ground.
d) The distances of the conductors from the pole axis.

4 Biological effects of electromagnetic fields, first identifications

It is a well-known fact and a reality that in all cases, the electromagnetic field or wave interacts with every body inserted in the field, dielectric, penetrating, biological being, etc. The degree of cooperation depends on the size of the field, i.e. the parameters that characterize it, such as the intensity of the electric field E, the intensity of the magnetic field H, the frequency f, the environment μ, ε, etc. and on the size and type of the body. In the interaction of the electromagnetic field with the human being, bioelectromagnetic problems arise and, at a first glance, ecological ones [15].

In a simplified treatment, even biological beings can be seen as objects in an electric, magnetic or electromagnetic field. In reality, they really represent electromagnetic systems of endogenous origin of biological nature: we are dealing with problems of bionics or bioelectromagnetism. In this way, the cooperations are complicated and the consequences are still unknown. This is an important new field of research that has been going on for several decades [16].

The potential effects on human health of artificial electromagnetic fields have attracted the attention of researchers since the end of the 19th century. We note that until 1970, the harmful effects of electromagnetic fields of low frequencies (50, 60 Hz) were not known, so there was no concern, with all the increasing extent of high voltage networks and voltage levels accomplished. In this sense, scientific thought was backward, no one was even concerned about the harm that electromagnetic fields could bring to human health [17].

Officially, the first concern arose in 1972, when at a CIGRES conference (International Conference of Large Electric Networks), Korobkova's paper was presented, in which neurological and cardiovascular disorders of the functional type, hematological modifications in the blood of female workers were noted. exposed to electromagnetic fields. The reference aroused a lot of interest, drew attention and above all encouraged scientific thought to focus on this new and extremely important field of study and experimentation [18].

Similarly, Asanova in Russia, pointed out that the workers exposed to the electromagnetic fields created in the 400-500 kV substations complained of a series of functional, neurological, cardiovascular, digestive disorders, pulse, tension, hematological norms, etc. Many experimental studies have been carried out and are carried out on animals, but the experimental conclusions in animals have limited values because they are not carried over to humans due to the great psychological, physiological and even morphological differences which lead to specific deformations of the external electric field, concentrations related to the shape of the animal's body [19] (ears, tail, etc.).

Coulomb's law, which was generated by Charles-Augustine de Coulomb, allows one to determine the electric force between two-point charges (Augustyn et al., 2024). Symbolically, this is described by the statement, $F = k_e \cdot \frac{q_1 \cdot q_2}{r^2} \cdot \vec{r}$, where $k_e = \frac{1}{4\pi\varepsilon_0}$, which is known as the Coulomb constant, q_1 and q_2 are the charges and r is the distance between these charges (. Furthermore, $\vec{r}$ is the unit vector along the line that joins the charges and ε_0 is the electric constant. If r_{12} is the displacement vector between the charges, $r_1 - r_2$, and $\vec{r_2}$ is the unit vector extending from q_2 to q_1, then the electrostatic force that is experienced by a charge at a particular position near another charge at a certain position in a vacuum is given by $F_1 = \frac{q_1 \cdot q_2}{4\pi \cdot \varepsilon_0} \cdot \frac{\vec{r_{12}}}{|r_{12}|^2}$. Finally, the force on a small test charge, q, at a position, r, in a vacuum, which is the continuous charge distribution. Symbolically, this would be $F(r) = \frac{q}{4\pi\varepsilon_0} \int dq' \cdot \frac{r - r'}{|r - r'|^2}$, but this does not apply when $|r - r'| = 0$ (see [48]).

In this case, Coulomb's law can be used to compute the electric field due to a charged wire. When the wire is long, straight, and uniformly charged with a linear charge density, λ, the corresponding equation is $E = \frac{1}{2\pi\varepsilon_0} \cdot \frac{\lambda}{r}$, where r is the perpendicular distance from the wire to the point in question [47]. By Faraday's law of induction, which states that the induced electric field must satisfy $\nabla \times E = -\frac{\partial B}{\partial t}$, where E is the electric field, V is the electric potential, and B is the time-dependent magnetic field, the electric field cannot be purely electrostatic such that $-$gradV, since the curl of the electric field is not zero. This applies to transmission lines when there are time-varying magnetic fields that are the result of alternating currents of perhaps, when there is electromagnetic interference nearby (see [49]).

Additionally, voltage gradients, which are calculated using the formula, $V = -\int E \cdot dr$, are associated with the integral of the electric field. These directly influence electric fields and predict overall system performance. The forces between charged conductors that are found using this law are vital for mechanical stability analysis, which entails confirming that the various components of transmission lines (structures, conductors, and insulators) can tolerate physical forces, including wind, tension, and electromagnetic forces. Knowing this, it becomes possible to prevent structural failure or errors such as excessive oscillations. For instance, electrostatic repulsion that occurs between conductors can cause mechanical tension and affect the amount of sag, as well as spacing, between transmission lines (See [50]). In conclusion, it is clear that Coulomb's law is important in the design and maintenance of transmission lines.

The electric field is given by the expression, $E = \frac{q \cdot \vec{r}}{4\pi \cdot \varepsilon_0 \cdot r^2}$. Gauss' law states that for a volume V, the equation

$$\oint_S E \cdot ds = \begin{cases} \frac{q}{\varepsilon_0}, & \text{if } \partial V \text{ encloses } q, \\ 0, & \text{given that } \partial V \text{ does not enclose } q, \end{cases}$$

holds and satisfies the second case of the law. By a theorem, it is clear that $\oint_{\partial V'} E \cdot d\sigma = \oint_S E \cdot ds + \frac{q}{4\pi\epsilon_0} \oint_S \frac{\vec{r} \cdot d\sigma'}{\sigma^2} = 0$. Here, $\oint_{\partial V'} E \cdot d\sigma$ is the flux of the electric field through the closed surface, $\partial V'$, which encloses a volume, V'. Flux is equivalent to the total charge enclosed within the volume that is divided by the permittivity of the free space given by ε_0. Continuing down the equation, one will encounter the term, $\oint_S E \cdot ds$, which is representative of the electric field that lies across an open surface that is not necessarily closed (S). The final term, $\frac{q}{4\pi\varepsilon_0} \oint_S \frac{\vec{r} \cdot d\sigma'}{\sigma^2}$, is the geometric contribution to the electric field flux. This statement makes the superposition principle apparent, as the total field may be decomposed into the results given by the charge distribution and field geometry. Since the statement is equivalent to 0, it is possible to see that there is no net charge enclosed within the closed surface, $\partial V'$, as it holds that if the flux is zero, then the enclosed charge is necessarily zero, as well. The electric field contributions cancel out due to symmetry, as evident from the result [47]. There are two cases of Gauss' law; one that concerns magnetic fields and another that deals with electric fields. In particular, the second case of Gauss' law is described by $\oint_S E \cdot d\sigma = -\frac{q}{4\pi \cdot \varepsilon_0} \cdot (-4\pi) = +\frac{q}{\varepsilon_0}$, which deals with electric fields. In integral form, this law would be one of Maxwell's equations $\nabla \cdot E = \frac{\rho}{\varepsilon_0}$, where $\nabla \cdot E$ is the divergence of the electric field, E is the field vector, and ρ is the volume charge density. Do not forget that ε_0 is the permittivity of free space, also known as the vacuum permittivity that relates the electric field to the charge distribution within a vacuum.

Gauss' law for magnetism is given by $\oint_{\partial V} B \cdot dA = 0$, for the magnetic field or magnetic flux density B, and the differential area vector, dA. The main principle is that magnetic field lines form closed loops and do not either originate anywhere or terminate, such that there are no magnetic monopoles. The defined expression becomes important when considering how perturbations in magnetic field lines act. With this mathematical representation of Gauss' law, perturbations in magnetic field lines can be understood. It ensures that any changes, including those of shape, direction, or intensity of magnetic field lines, are unable to create or destroy net magnetic flux over a closed surface. Compression is the consequence of magnetic field lines being closed together, which in turn, increases the local magnetic field strength. Expansion follows from the magnetic field lines being spread out, which reduces this strength. The statement shows that overall flux remains unchanged, despite the compression or expansion to field lines in certain regions due to perturbations that may affect the local field strength (the value of B) and the angle of the field relative to dA. Changes to local field configurations do not necessarily lead to violations of flux conservation. The law allows one to analyze whether internal magnetic field distributions are stable, despite external perturbations.

Beyond the computation of electric fields that is permitted by Gauss' law, using what is known about symmetry, the field that exists between two oppositely charged conductors may be calculated for each conductor and superposed so that the net field of the region may be calculated. With the expression for voltage gradient extending from Gauss' law, $E = -\lambda V$, the field strength and potential differences may be computed. This becomes important when designing insulation for transmission lines and minimizing the risk of breakdowns. Applied to magnetism, Gauss' law makes it certain that field interactions are both consistent and predictable for the mitigation of electromagnetic interference (see [50]).

The main conclusions of the studies carried out during the period 1970-1990 can be systematized as follows:

Comment a: *We differ from the past in that the problems of the interaction of the electromagnetic fields of low frequencies and the human organism were practically undetected, invisible, now even with initial results, attention was drawn to this interaction and to them clarified that, since then many studies have been carried out.*

Comment b: *The observed changes in many biological parameters, although reversible, were a warning for special pathological risks.*

Comment c: *The studies carried out, often isolated, mainly of an experimental statistical character, without sound methodologies, etc., could not reduce the problem to the levels achieved.*

Comment d: *The fact that in all cases dispersions were observed in the blood formula, increase of leukocytes, although in the form of a reversible phenomenon or process. According to special opinions, they can be closely related to the hypothesis and the risk of leukemia for people exposed to this field.*

5 Hypothesis on the influence of the electromagnetic field on the human body

The most important hypothesis, which is widely discussed today, is that of the influence of the electromagnetic field on the functioning of the pineal gland. Without going into the details of the biological nature, we are trying to briefly present in this study the essence of the problem, i.e. the concern [20].

The pineal gland (pineal, brain, cerebral) is part of the endocrine system and is located in the back of the brain stem. It secretes a hormone called melatonin.

Melatonin in the human body plays various and extremely important roles: among them we can mention: The impact on sleep, and the aging process, the modulation and regulation of sexual secretions, a regulatory impact on the immune system, etc.: some researchers think that melatonin has an impact on Alzheimer's disease (specific sclerosis of the central nervous system), Parkinson's disease and cancer pathology. So it is an endocrine gene with a lot of responsibility in the biological functions of the organism. Among the negative external factors that affect the functioning of this gland, i.e. the production of melatonin, we can mention the effect of light and the magnetic field [21].

Experience has proven that the pineal gland is sensitive to light. It is quite active during the night, the peak of its secretion is from 8 pm to 6 am. It is said that if you sleep in a room that is not darkened very well, after a few weeks the pineal gland shifts its peak to the production of melatonin, so the secretion of this hormone decreases. Therefore, one of the important recommendations is to teach children, especially, to sleep in complete darkness.

An exposure to a magnetic field greater than 2 mG would have an effect on melatonin secretion [22]. Just like exposure to light, exposure to a magnetic field leads to sleep disturbances, disturbed sleep with behavioral disturbances: if this situation lasts, it passes over time to physical and intellectual deficiencies in adults and to a depressive state (starting from an exposure of 1mG). It is also said that even small values of magnetic fields of very low frequencies are sufficient to regulate the functioning of the pineal gland.Such a thing has been proven in pigeons long under the action of weak magnetic fields, the reduction of melatonin production has been found.

The hypothesis put forward, where as a result of it there is the assumption about the influence of melatonin disturbances in the birth and development of some cancerous diseases [23]. In the leadership, the opinion that melatonin deficiency increases the risk of cancer is not uncommon. It is said that the cell is affected by the magnetic field, its functioning is "blocked" and thus favors the appearance of certain types of cancer, especially breast cancer; the opposite is also said, the melatonin that penetrates the cancer cells exerts a curative effect. In a special study, it is pointed out that in highly lit environments in urban areas, there is an increased occurrence of breast cancer. So, the hypothesis presented above shows the positive effects of melatonin when the pineal gland is functioning normally and the cancerous risks when it is not functioning normally. It is emphasized that melatonin is a powerful antioxidant that destroys free "radicals" produced spontaneously in the body [24]. Yes, this hormone in this sense contributes to inhibiting the cancerous process. The reduction of its secretion under the effect of the electromagnetic field has the opposite effect, increasing the risk of cancer, especially of the breast.

Hypothesis for the effects on calcium ions. Calcium ions (Ca++) play an important role in the function and regulation of cellular activity. One can think of the importance if the magnetic fields have an effective action in the movement of these ions. This opinion has prompted a series of special studies to point out the movement of calcium ions in a living system under the action of low frequency magnetic fields, even with intensities comparable to those of the earth's magnetic field, etc. Disruption of their movement causes cell penetration to be disorganized, thus cellular functioning is also disorganized.

First of all, we are talking about the permeability of calcium ions in the cell membrane with a special importance in the cellular metabolism that is affected by the exposure to electromagnetic fields of low frequencies [25].

Studies, hypotheses and other concerns. Recently, new facts have been brought about the impact of electromagnetic radiation of low frequencies on human health. There is a statement by G.S. Hylond, etc., in 1999 in an article entitled *"Security rates are inappropriate", "even the philosophy that guides their formula is wrong"*.

According to the authors, the basis of the existing norms is the absorption of energy from the environment and induced currents in the case of exposure to electromagnetic fields of low frequencies. But the existing norms do not take into account that living matter can react in completely different ways, compared to other matters.

In biology, many causes are signals, the effects of which are reinforced according to different processes. For this purpose, the authors provide an excellent example. We are talking about the light of a stroboscope, with a frequency of 15-20 Hz; no matter how weak the intensity of this light is, it is able to provoke an epilepsy crisis in some predisposed subjects. It is not about the amount of energy absorbed, which is negligible compared to the great energy developed by the subject during the crisis. *Here we are dealing more with a frequency that the brain "knows" because it is equal or close to what the brain itself uses, so we are more dealing with a resonance phenomenon* [26].

In this sense, a non-linear relationship is observed between cause, signal and effect, biological process, epilepsy crisis. The problem is quite similar to a case from life. When the plane is flying, the use of the mobile phone is not allowed: one of its frequencies could enter into resonance with the many resonant electrical circuits of the plane's steering and at the very least the steering parameters could be adjusted.

It is said that when the mobile phone is working, in the wave emitted by it, there is also a component with a frequency of 2 Hz; this frequency is in the interval of cerebral waves called "delta", which if noted in an ECG, are symptoms of a nervous disease and it should not be favored through such an exposure [27].

Likewise, a light source of an electromagnetic wave of a low frequency can provoke some neurological (electrochemical) processes that are characterized by that frequency, or by a frequency close to it; therefore, an amplification of an electrical activity can arise at the biological level, so a resonance will always appear. So it is possible that an external radiation increases the natural level of metabolism, thus generating an internal activity [28].

The Russians were the first to use non-ionizing electromagnetic radiation for military purposes during the Cold War. In many studies, it is pointed out that for certain frequencies, special phenomena are produced, that is, there is talk of a "window effect", nothing is manifested outside of them. There are phenomena that manifest in all frequencies. This is the disturbing case of the breakdown of the hemato-cerebral barrier. The breakdown of this barrier, its deformation, affects, among other things, the metabolism of calcium, which has consequences for the body. An important conclusion that has resulted from the study is that modulated waves such as those of mobile phone frequencies cause other effects to appear compared to a monochromatic wave. When the nervous system is exposed to Hertzian waves, modifications can be created. morphological, electrophysiological and chemical and in the literature it is said that this leads to the modification of the hemato-cerebral barrier, cellular metabolism, neurons, calcium flow, etc. There are hypotheses for the cumulative character of the exposure and therefore in the increase of the modification to DNA for which H. Lai is clear and categorical [29]. Stresses caused by electromagnetic waves have a cumulative character. The chronic aspect of exposure, even with small intensities, leads to the same effects as with high intensities.

6 The relationship between magnetic and electric fields

In Figure 2, a high voltage pole with three conductors is physically presented.

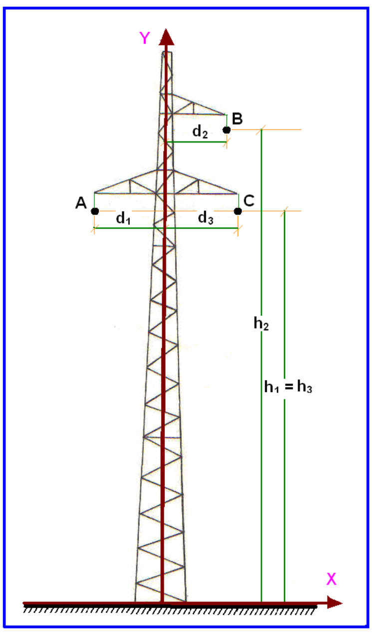


Figure 2. Diagram of High Voltage Pole

The electromagnetic field of a certain line, in an intuitive engineering point of view, is accepted as a parallel plane. The analysis of the electromagnetic field will be done in the transverse plane XOY. Since the height of the conductors in relation to the ground really changes and the electric field would not be a parallel plane, the one in the middle of the camp would be more intense as a result of the influence of the ground [30].

However, for a global view of the electric field, it can be considered a parallel plane. The lines of force (E) start from the conductor and go to the ground and to the other conductor, the equipotential lines are perpendicular to them and the ground is an equipotential surface with $U = 0$. So, the tangential component E_t is negligible. The electric field has only the normal component E_n and as a consequence the magnetic field with a circular configuration is transverse to it. The field on the earth's surface is half of the field created by these transmitters and their reflections.

The vertical component of the electric field on the ground is determined by the expression:

$$E_y\left(\frac{kV}{m}\right) = k_1 U\left[A - \frac{1}{2}(B+C) + j\frac{\sqrt{3}}{2}(B-C)\right].$$

The horizontal component of the magnetic field created by the high voltage line, in (or near) the earth's surface is determined by the expression:

$$B_x(T) = k_2 I\left[A - \frac{1}{2}(B+C) + j\frac{\sqrt{3}}{2}(B-C)\right].$$

In the above expression we have:

$$A = \frac{h_1}{(x-d_1)^2 + h_1^2}; \quad B = \frac{h_2}{(x-d_2)^2 + h_1^2}; \quad C = \frac{h_3}{(x-d_3)^2 + h_3^2},$$

where H, d, and x are quantities expressed in meters. Additionally, U is the phase voltage expressed in kV, I is the current expressed in amperes, and k_1, k_2 are constants with the following values.

$$k_1 = \frac{0.4}{\sqrt{3}} \text{ and } k_2 = 0.2 \cdot 10^{-5}.$$

Comment: We notice that the expression of E is completely dual to that of B, the coefficients before the brackets that pass the problem from the electric field E to the magnetic field B are different. The ratio between them is

$$\frac{B_x(T)}{E_y(\frac{kV}{m})} = \frac{B}{E} = \frac{k_2}{k_1} \cdot \frac{I}{U} = \frac{0.2 \cdot 10^{-6}}{0.4/\sqrt{3}} \cdot \frac{I}{U},$$

$$\frac{B_x(\mu T}{E_y(kV/m)} = \frac{0.2}{0.4} \cdot \sqrt{3} \cdot \frac{I}{U} = 0.86 \cdot \frac{I}{U}.$$

For the specific case where $I = 1945A$ and $U = 400kV$, we have

$$B = 0.86 \cdot \frac{1,945}{400} \cdot E = 4.2 \cdot E.$$

So, the graph of E is also the graph of B if we correct the latter with the coefficient 4.2.

7 The magnetic field and the electric field in the electric power transmission lines, with a voltage level of 400 kV, in the Albanian electric power system

In the Albanian electrical system, lines with a voltage level of 400 kV have a particularly important role, as they serve to supply electricity to some of the largest cities in the country, as well as connecting the system in question in parallel with the European energy system [31]. From this point of view, these lines have a considerable weight in the system and the power flows that circulate in these lines constitute the basic column of electricity supply for family consumers as well as for heavy industry in the country.

The aforementioned lines that are part of the Albanian electrical system are as follows.

Line Elbasan .2 - Zemblak - Kardia with a length of 195,558 km.

Line Tirana .2 - Elbasan.2 with a length of 47 km.

Tirana Line .2 – Vau i Dejes with a length of 76.13 km.

Vau i Dejes - Kosove line with a length of 172.37 km.

Line Vau i Dejes – Podgoric with a length of 80.81 km.

In the following we study the line Tirana .2 - Vau i Dejes with a length of 76.13 km, as it pertains to the electric and magnetic fields, as well as a more detailed explanation of the weight it has in the system as well as the power flows that circulate in them.

The study of the magnetic and electric field is done in the vicinity of the pole as well as in the middle of the camp. For the middle of the camp, we consider three cases that have different heights from the ground depending on the area where they pass. We have unpopulated areas, populated areas and those areas where the camp passes over vehicle and pedestrian roads. The heights of the conductors from the ground for lines with a voltage level of 400 kV according to the category of the area in which they pass are [32]:

The height of the conduits from the ground for residential areas: $H = 9\ m$.

The height of the conduits from the ground for uninhabited areas: $H = 8\ m$.

The height of the conduits from the ground for road areas: $H = 10\ m$.

In the following, for each case, the calculations were performed and the corresponding curves of the electric and magnetic fields were constructed.

7.1 Tirana Line 2 – Vau i Dejes *(Figure 3)*

This line is of great importance for the Albanian electric energy system as it is the only line with a voltage level of 400 kV and with two circuits for our country and the extension of one circuit in the direction of Kosovo and the other in the direction of Podgorica connects our energy system in parallel with the European electrical system. This will further increase the security of our country's electricity supply and will also positively affect the stability of the system. In cases where the production of electricity in our country cannot cover all the demand for electricity from consumers in the country, this inhibition occurs mainly in the summer period, through this line energy will be imported from Kosovo and other countries for mainly supplied to the south of Albania as the demand in the latter is greater due to coastal tourism. So, in this line, the largest flows of power will circulate compared to other lines that are part of the Albanian electrical system [33].

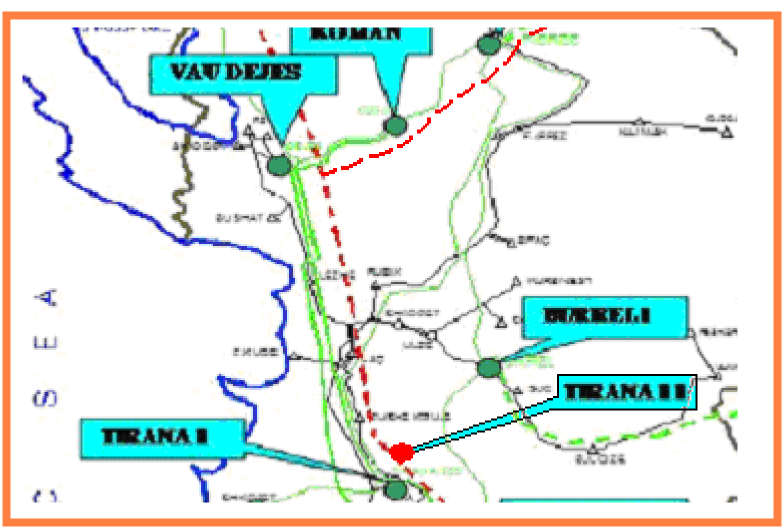


Figure 3. Map of the Tirana 2 - Vau i Dejes Line

Figure 4. a & b Shows the model of the pole used in this line as well as its geometric parameters expressed in meters. The type of this pole is 2NS - 400.

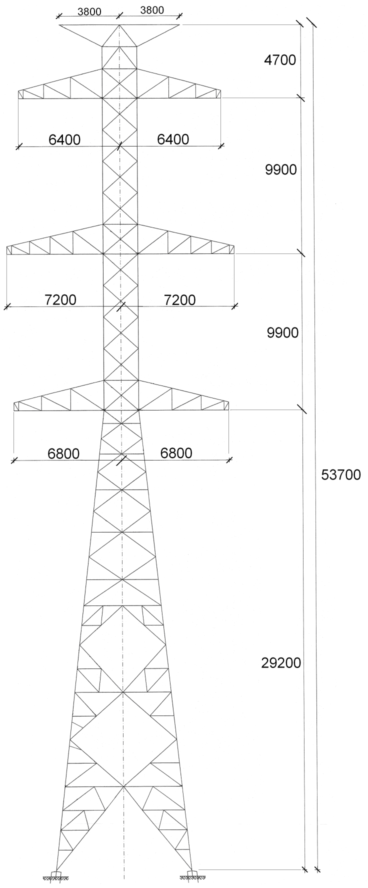


Figure 4. a Graphically presented diagram in the horizontal plane.

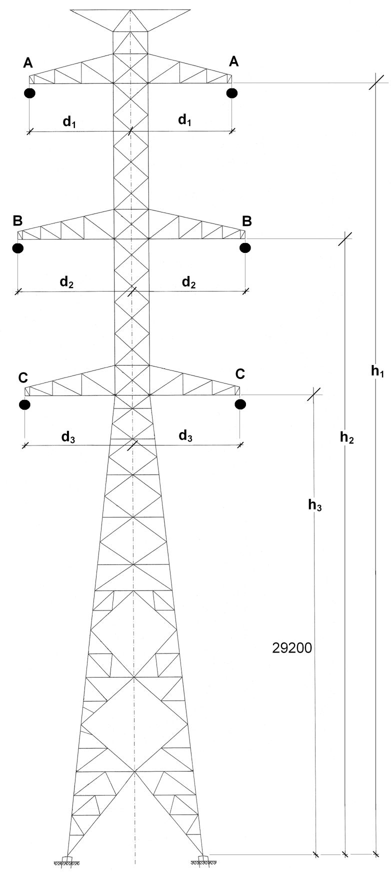
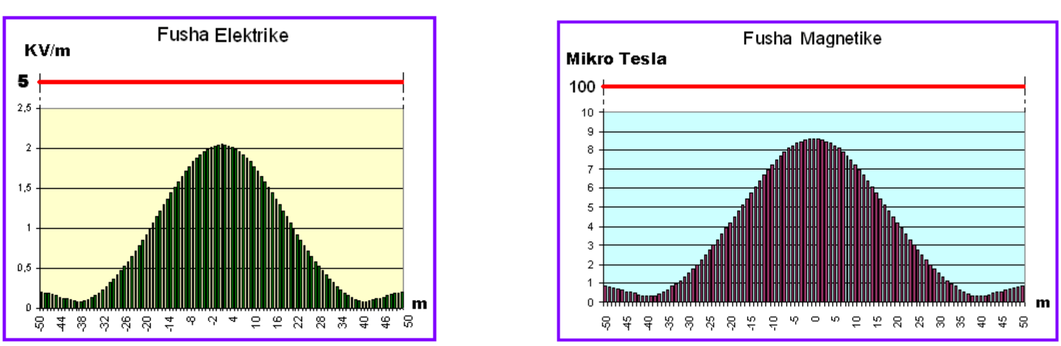


Figure 4. b Shows the distance of the transmissions from the ground and the axis of the pillar.

The physical and electrical parameters of the line, which are needed to calculate the electric and magnetic field, are determined by the geometric parameters of the pole, while the electrical parameters are determined by the project of this line. The geometric parameters needed for the calculator are the distances of the conductors from the ground (h1, h2, h3) and from the pole axis (d1, d2, d3). Figure 4.a graphically shows the distances of the conductors from the ground and from the pole axis [34].

Distances from the pole axis: $d_1 = 6.4m$; $d_2 = 7.2m$; $d_3 = 6.8m$.
Distances from the ground: $h_1 = 49m$; $h_2 = 39m$; $h_3 = 29m$.
Nominal voltage $U_n = 400kV$; Nominal current $I_n = 1948A$.



$(E = Ey)$ and $(B = Bx)$
Figure 5. Graphic Representation of the Electric and Magnetic Field at the Pole (at a distance of 1 m from the Ground)

Distanca	Fusha elektrike	Fusha magnetike
-50	0,199027348	0,83940654
-49	0,189188054	0,79790889
-48	0,178432421	0,75254653
-47	0,166755556	0,70329885
-46	0,154186618	0,6502888
-45	0,140814452	0,59389111
-44	0,126834862	0,53493158
-43	0,112640352	0,47506561
-42	0,098990052	0,41749487
-41	0,087300622	0,36819419
-40	0,079954195	0,33721031
-39	0,079949362	0,33718993
-38	0,089128651	0,37590398
-37	0,106882012	0,45077956
-36	0,131380683	0,55410377
-35	0,161067805	0,67931051
-34	0,194982796	0,82234847
-33	0,232591652	0,98096546
-32	0,273604698	1,15393978
-31	0,317862856	1,34060049
-30	0,365273244	1,54055587
-29	0,415772197	1,75353742
-28	0,469302778	1,97930498
-27	0,525799983	2,21758442
-26	0,585180192	2,46802304
-25	0,64733307	2,73015552
-24	0,712115066	3,00337642
-23	0,779344079	3,28691772
-22	0,848795171	3,57983074
-21	0,92019733	3,88097247
-20	0,993231416	4,18899692
-19	1,067529417	4,50235198
-18	1,142675198	4,8192826
-17	1,218206879	5,13784077
-16	1,293620927	5,45590281
-15	1,368377973	5,77119392
-14	1,441910277	6,08131963
-13	1,513630628	6,38380335
-12	1,582942379	6,67612868
-11	1,649250181	6,95578474
-10	1,711970947	7,22031231
-9	1,770544502	7,46734884
-8	1,824443417	7,69466987
-7	1,873181578	7,9002252
-6	1,916321188	8,08216838
-5	1,953478018	8,23887894
-4	1,984324952	8,36897723
-3	2,00859399	8,47133296
-2	2,02607705	8,54506853
-1	2,036625963	8,58955903
0	2,040152098	8,60443066
1	2,036625963	8,58955903
2	2,02607705	8,54506853
3	2,00859399	8,47133296
4	1,984324952	8,36897723
5	1,953478018	8,23887894
6	1,916321188	8,08216838
7	1,873181578	7,9002252
8	1,824443417	7,69466987
9	1,770544502	7,46734884
10	1,711970947	7,22031231
11	1,649250181	6,95578474
12	1,582942379	6,67612868
13	1,513630628	6,38380335
14	1,441910277	6,08131963
15	1,368377973	5,77119392
16	1,293620927	5,45590281
17	1,218206879	5,13784077
18	1,142675198	4,8192826
19	1,067529417	4,50235198
20	0,993231416	4,18899692
21	0,92019733	3,88097247
22	0,848795171	3,57983074
23	0,779344079	3,28691772
24	0,712115066	3,00337642
25	0,64733307	2,73015552
26	0,585180192	2,46802304
27	0,525799983	2,21758442
28	0,469302778	1,97930498
29	0,415772197	1,75353742
30	0,365273244	1,54055587
31	0,317862856	1,34060049
32	0,273604698	1,15393978
33	0,232591652	0,98096546
34	0,194982796	0,82234847
35	0,161067805	0,67931051
36	0,131380683	0,55410377
37	0,106882012	0,45077956
38	0,089128651	0,37590398
39	0,079949362	0,33718993
40	0,079954195	0,33721031
41	0,087300622	0,36819419
42	0,098990052	0,41749487
43	0,112640352	0,47506561
44	0,126834862	0,53493158
45	0,140814452	0,59389111
46	0,154186618	0,6502888
47	0,166755556	0,70329885
48	0,178432421	0,75254653
49	0,189188054	0,79790889
50	0,199027348	0,83940654

	Vlera	X
Maxi E	2,0402	0
Maxi B	8,6044	0
Min E	0,0799	-39
Min B	0,3372	-39

Distanca	m
Fusha Elektrike	KV/m
Fusha Magnetike	Mikro Tesla

Table 2. Values of the Magnetic and Electric Fields at the Pole [35].
Note on the words used in the Table 2: Distanca = Distances; Fusha Elektrike = Electric Field; Fusha Magnetike = Magnetic Field.

8 Conclusion 1

From the study of the electric and magnetic field of the line Tirana 2 - Vau i Dejes to the pole at a distance of 1 m from the ground, we draw some very important engineering conclusions for the values and distribution of the fields in question. From the graphic and numerical presentation of the values of these fields, it can be seen that:

1. These fields are within the norms recommended in our country for the population which is exposed to these fields in a 24-hour period.

2. The distribution of the fields in question includes an area with a radius of 55 m away from the pillar.

3.Both fields have a maximum with coordinates and values as below.

The maximum electric field is at the pole (at a distance of 0 m) with a value of $2.0402 kV/m$. So, $E_{max} = E_{y_{max}} = 2.0402\, kV/m$.

The maximum of the magnetic field is at the pole (at a distance of 0 m) with a value of 8.6044 micro tesla. So, $B_{max} = B_{y_{max}} = 8.6044$ micro tesla.

4. So, as can be seen from the maximum values that these fields have at their maximum, referring to Enel's norms in Italy, these fields, at the poles, are within the recommended norms and do not pose a risk to people who are exposed, against these fields, for a long time.

5. As can be seen from the graphs, at the pole, the fields are quite regular because the height of the wires from the ground is very high and the influence of the ground on the fields in question is zero.

8.1 Electric and magnetic field in the middle of the camp

Below are presented graphically the values of the electric and magnetic field in the middle of the camp for three cases [36].

1. The middle of the camp in uninhabited areas,
2. the middle of the camp on the road,
3. the middle of the camp in residential areas.

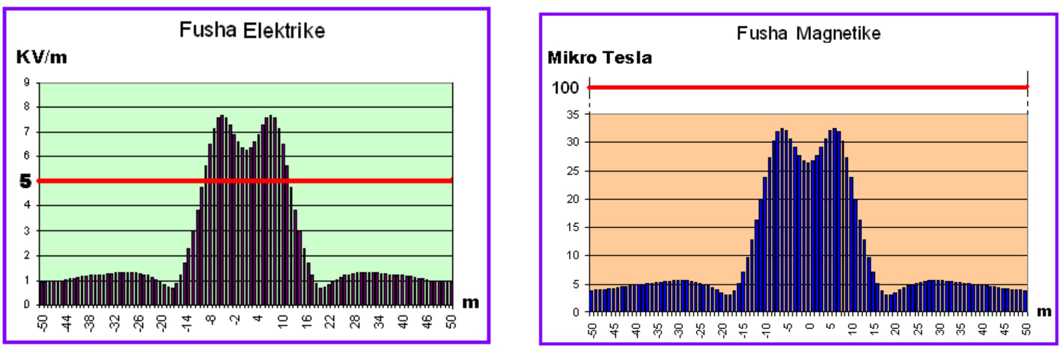
The heights of the conduits from the ground for each of the aforementioned areas are as follows.

For uninhabited areas: $h_1 = 28\,m$; $h_2 = 18\,m$; $h_3 = 8\,m$.

For roads: $h_1 = 30\,m$; $h_2 = 20\,m$; $h_3 = 10m$.

For residential areas: $h_1 = 29\,m$; $h_2 = 19\,m$; $h_3 = 9\,m$.

In the following, the values of the electric and magnetic fields for each of the above areas are presented graphically and in tabular form [37].



$(E = E_y)$ and $(B = B_x)$

Figure 6. Graphic presentation of the electric and magnetic fields for uninhabited areas at a distance of 1m from the ground.

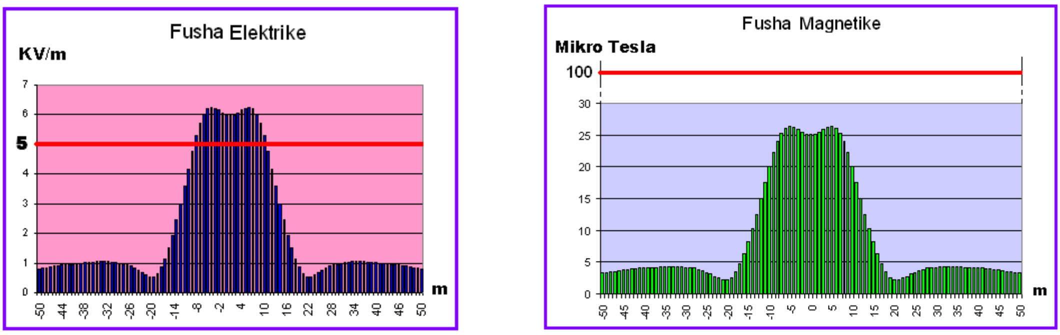
Table 3. Now, we have the numerical presentation of electric and magnetic fields for uninhabited areas at a distance of 1m from the ground.

Distanca	Fusha elektrike	Fusha magnetike
-50	0,881645411	3,71837806
-49	0,904420221	3,81443182
-48	0,927719641	3,91269814
-47	0,951516735	4,01306343
-46	0,975775386	4,11537535
-45	1,000448514	4,21943534
-44	1,025475966	4,32498972
-43	1,050782022	4,43171911
-42	1,076272427	4,53922601
-41	1,101830876	4,64701989
-40	1,127314829	4,75449957
-39	1,152550528	4,86093224
-38	1,17732706	4,96542834
-37	1,201389269	5,06691176
-36	1,224429287	5,16408405
-35	1,246076422	5,25538179
-34	1,265885073	5,33892564
-33	1,283320339	5,41245963
-32	1,297740957	5,47327922
-31	1,308379251	5,51814669
-30	1,314317967	5,54319348
-29	1,314464322	5,54381074
-28	1,307522627	5,51453384
-27	1,29196916	5,44893641
-26	1,266037899	5,33957019
-25	1,227736814	5,17803369
-24	1,174939813	4,95536003
-23	1,10566119	4,6631744
-22	1,018778567	4,29674314
-21	0,915902745	3,86285987
-20	0,806242732	3,40036397
-19	0,718286709	3,02940559
-18	0,715416328	3,01729964
-17	0,870639136	3,67195862
-16	1,198981395	5,05675645
-15	1,677287048	7,07403145
-14	2,287909653	9,64935898
-13	3,018768069	12,7317863
-12	3,851654443	16,244521
-11	4,751722537	20,0405975
-10	5,660198372	23,8721341
-9	6,49423864	27,3897354
-8	7,159335467	30,1948103
-7	7,575473265	31,9498897
-6	7,707681188	32,5074824
-5	7,583167365	31,9823399
-4	7,282883344	30,7158789
-3	6,913043869	29,1560647
-2	6,574186525	27,7269191
-1	6,341612318	26,7460272
0	6,259361373	26,3991302
1	6,341612318	26,7460272
2	6,574186525	27,7269191
3	6,913043869	29,1560647
4	7,282883344	30,7158789
5	7,583167365	31,9823399
6	7,707681188	32,5074824
7	7,575473265	31,9498897
8	7,159335467	30,1948103
9	6,49423864	27,3897354
10	5,660198372	23,8721341
11	4,751722537	20,0405975
12	3,851654443	16,244521
13	3,018768069	12,7317863
14	2,287909653	9,64935898
15	1,677287048	7,07403145
16	1,198981395	5,05675645
17	0,870639136	3,67195862
18	0,715416328	3,01729964
19	0,718286709	3,02940559
20	0,806242732	3,40036397
21	0,915902745	3,86285987
22	1,018778567	4,29674314
23	1,10566119	4,6631744
24	1,174939813	4,95536003
25	1,227736814	5,17803369
26	1,266037899	5,33957019
27	1,29196916	5,44893641
28	1,307522627	5,51453384
29	1,314464322	5,54381074
30	1,314317967	5,54319348
31	1,308379251	5,51814669
32	1,297740957	5,47327922
33	1,283320339	5,41245963
34	1,265885073	5,33892564
35	1,246076422	5,25538179
36	1,224429287	5,16408405
37	1,201389269	5,06691176
38	1,17732706	4,96542834
39	1,152550528	4,86093224
40	1,127314829	4,75449957
41	1,101830876	4,64701989
42	1,076272427	4,53922601
43	1,050782022	4,43171911
44	1,025475966	4,32498972
45	1,000448514	4,21943534
46	0,975775386	4,11537535
47	0,951516735	4,01306343
48	0,927719641	3,91269814
49	0,904420221	3,81443182
50	0,881645411	3,71837806

	Vlera	X
Maxi E	7,7077	-6
Maxi B	32,5075	-6
Min E	0,7154	-18
Min B	3,0173	-18

Distanca	m
Fusha Elektrike	KV/m
Fusha Magnetike	Mikro Tesla

Note on the words used in the Table 3: Distanca = Distances; Fusha Elektrike = Electric Field; Fusha Magnetike = Magnetic Field.



$(E = E_y)$ and $(B = B_x)$

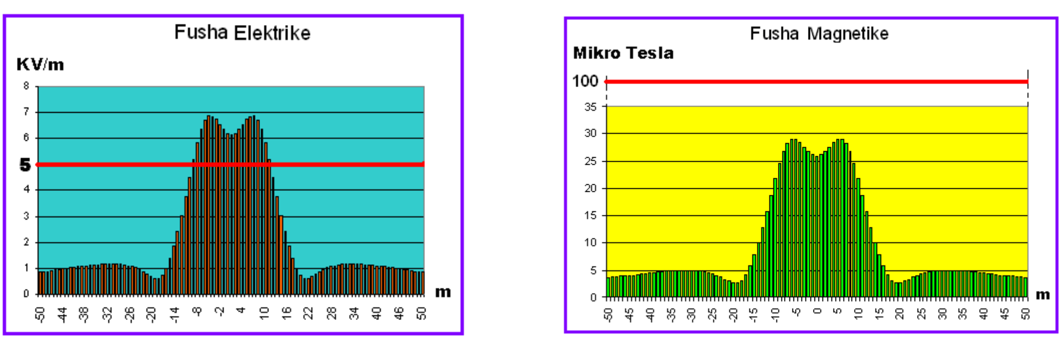
Figure 7. Graphic Representation of the Electric and Magnetic Fields on the Road at a Distance of 1m from the Ground.

Distanca	Fusha elektrike	Fusha magnetike
-50	0,806988337	3,40350859
-49	0,824874136	3,47894273
-48	0,842905309	3,55498999
-47	0,861022213	3,63139882
-46	0,879153124	3,70786673
-45	0,897212242	3,78403186
-44	0,915097372	3,85946317
-43	0,932687223	3,93364914
-42	0,949838275	4,00598445
-41	0,966381137	4,07575469
-40	0,982116321	4,14211852
-39	0,996809336	4,20408695
-38	1,010185027	4,26049951
-37	1,021921049	4,3099967
-36	1,031640397	4,35098847
-35	1,038902947	4,3816186
-34	1,043196025	4,39972484
-33	1,043924171	4,40279583
-32	1,040398558	4,3879264
-31	1,031827087	4,35177585
-30	1,017307234	4,29053773
-29	0,995825858	4,19993909
-28	0,966274448	4,07530473
-27	0,927497276	3,91176031
-26	0,878409754	3,70473154
-25	0,818270553	3,45109183
-24	0,747304277	3,15178846
-23	0,668154611	2,81797128
-22	0,589277235	2,4853025
-21	0,531810742	2,24293505
-20	0,535184828	2,25716541
-19	0,63767851	2,68943699
-18	0,843649811	3,55812996
-17	1,137411476	4,79708262
-16	1,506602268	6,35416093
-15	1,944023596	8,1990045
-14	2,443108937	10,3039187
-13	2,993989053	12,6272797
-12	3,580590054	15,1012951
-11	4,178878778	17,6246039
-10	4,756950369	20,0626461
-9	5,277885436	22,2597126
-8	5,70576872	24,064329
-7	6,013839557	25,3636312
-6	6,192052798	26,1152534
-5	6,250705982	26,3626257
-4	6,218203751	26,2255462
-3	6,133806683	25,8695978
-2	6,038363457	25,4670619
-1	5,966160396	25,1625423
0	5,939527857	25,0502184
1	5,966160396	25,1625423
2	6,038363457	25,4670619
3	6,133806683	25,8695978
4	6,218203751	26,2255462
5	6,250705982	26,3626257
6	6,192052798	26,1152534
7	6,013839557	25,3636312
8	5,70576872	24,064329
9	5,277885436	22,2597126
10	4,756950369	20,0626461
11	4,178878778	17,6246039
12	3,580590054	15,1012951
13	2,993989053	12,6272797
14	2,443108937	10,3039187
15	1,944023596	8,1990045
16	1,506602268	6,35416093
17	1,137411476	4,79708262
18	0,843649811	3,55812996
19	0,63767851	2,68943699
20	0,535184828	2,25716541
21	0,531810742	2,24293505
22	0,589277235	2,4853025
23	0,668154611	2,81797128
24	0,747304277	3,15178846
25	0,818270553	3,45109183
26	0,878409754	3,70473154
27	0,927497276	3,91176031
28	0,966274448	4,07530473
29	0,995825858	4,19993909
30	1,017307234	4,29053773
31	1,031827087	4,35177585
32	1,040398558	4,3879264
33	1,043924171	4,40279583
34	1,043196025	4,39972484
35	1,038902947	4,3816186
36	1,031640397	4,35098847
37	1,021921049	4,3099967
38	1,010185027	4,26049951
39	0,996809336	4,20408695
40	0,982116321	4,14211852
41	0,966381137	4,07575469
42	0,949838275	4,00598445
43	0,932687223	3,93364914
44	0,915097372	3,85946317
45	0,897212242	3,78403186
46	0,879153124	3,70786673
47	0,861022213	3,63139882
48	0,842905309	3,55498999
49	0,824874136	3,47894273
50	0,806988337	3,40350859

	Vlera	X
Maxi E	6,2507	-5
Maxi B	26,3626	-5
Min E	0,5318	-21
Min B	2,2429	-21

Distanca	m
Fusha Elektrike	KV/m
Fusha Magnetike	Mikro Tesla

Table 4. This is a numerical presentation of the electric and magnetic field on the road at a distance of 1 m from the ground [38].
Note on the words used in the Table 2: Distanca = Distances; Fusha Elektrike = Electric Field; Fusha Magnetike = Magnetic Field, as before.



$(E = E_y)$ and $(B = B_x)$

Figure 8. Graphs of the Electric and Magnetic fields for Residential Areas at a Distance of 1m from the Ground

Table 5. This is the numerical representation of electric and magnetic fields for residential areas at a distance of 1 m from the ground [39].

Distanca	Fusha elektrike	Fusha magnetike
-50	0,844465002	3,56156806
-49	0,86477346	3,64721987
-48	0,885411678	3,73426246
-47	0,90633543	3,8225093
-46	0,927489695	3,91172833
-45	0,94880673	4,00163386
-44	0,970203827	4,09187705
-43	0,991580661	4,18203479
-42	1,012816189	4,27159656
-41	1,033765	4,35994908
-40	1,054253021	4,4463582
-39	1,074072472	4,5299476
-38	1,092975932	4,60967378
-37	1,110669366	4,6842966
-36	1,126803939	4,75234487
-35	1,140966465	4,81207595
-34	1,152668284	4,86142888
-33	1,161332473	4,89797047
-32	1,166279372	4,91883424
-31	1,16671067	4,92065325
-30	1,161692849	4,89949038
-29	1,15014189	4,8507737
-28	1,130813389	4,7692549
-27	1,102306932	4,64902767
-26	1,06310365	4,48368612
-25	1,011678465	4,26679815
-24	0,946782129	3,99309502
-23	0,868122625	3,66134512
-22	0,77802529	3,28135567
-21	0,685501631	2,8911331
-20	0,615170519	2,59450855
-19	0,616642547	2,6007169
-18	0,741890177	3,12895425
-17	0,999060511	4,21358138
-16	1,369194921	5,77463944
-15	1,837567795	7,75002251
-14	2,395124676	10,101543
-13	3,031496598	12,7854694
-12	3,728851113	15,7265926
-11	4,457347311	18,7990571
-10	5,173172622	21,8180817
-9	5,821204532	24,5511846
-8	6,344040682	26,7562689
-7	6,696488518	28,2427331
-6	6,860388768	28,9339895
-5	6,852288748	28,8998274
-4	6,71933033	28,3390694

Distanca	Fusha elektrike	Fusha magnetike
-3	6,525421907	27,5212522
-2	6,334690339	26,7168334
-1	6,198700242	26,1432893
0	6,149747796	25,9368302
1	6,198700242	26,1432893
2	6,334690339	26,7168334
3	6,525421907	27,5212522
4	6,71933033	28,3390694
5	6,852288748	28,8998274
6	6,860388768	28,9339895
7	6,696488518	28,2427331
8	6,344040682	26,7562689
9	5,821204532	24,5511846
10	5,173172622	21,8180817
11	4,457347311	18,7990571
12	3,728851113	15,7265926
13	3,031496598	12,7854694
14	2,395124676	10,101543
15	1,837567795	7,75002251
16	1,369194921	5,77463944
17	0,999060511	4,21358138
18	0,741890177	3,12895425
19	0,616642547	2,6007169
20	0,615170519	2,59450855
21	0,685501631	2,8911331
22	0,77802529	3,28135567
23	0,868122625	3,66134512
24	0,946782129	3,99309502
25	1,011678465	4,26679815
26	1,06310365	4,48368612
27	1,102306932	4,64902767
28	1,130813389	4,7692549
29	1,15014189	4,8507737
30	1,161692849	4,89949038
31	1,16671067	4,92065325
32	1,166279372	4,91883424
33	1,161332473	4,89797047
34	1,152668284	4,86142888
35	1,140966465	4,81207595
36	1,126803939	4,75234487
37	1,110669366	4,6842966
38	1,092975932	4,60967378
39	1,074072472	4,5299476
40	1,054253021	4,4463582
41	1,033765	4,35994908
42	1,012816189	4,27159656
43	0,991580661	4,18203479

Distanca	Fusha elektrike	Fusha magnetike
44	0,970203827	4,09187705
45	0,94880673	4,00163386
46	0,927489695	3,91172833
47	0,90633543	3,8225093
48	0,885411678	3,73426246
49	0,86477346	3,64721987
50	0,844465002	3,56156806

	Vlera	X
Maxi E	6,8604	-6
Maxi B	28,9340	-6
Min E	0,6152	-20
Min B	2,5945	-20

Distanca	m
Fusha Elektrike	KV/m
Fusha Magnetike	Mikro Tesla

Note on the words used in the Table 4: Distanca = Distances; Fusha Elektrike = Electric Field; Fusha Magnetike = Magnetic Field.

9 Conclusion 2

From the study of the electric and magnetic field for the line Tirana.2 - Vau i Dejes in the middle of the camp, at a distance of 1 m from the ground, we come to the set of conclusions listed here.

1. *The electric field exceeds the rates recommended for our country, while the magnetic field does not exceed these rates.*

2. *But, even though the magnetic field does not exceed the recommended norms for our country, the values it has are considerable and should not be treated with disdain.*

3. *The electric and magnetic fields include an area with a radius of 55 m centered in the middle of the camp and have two maxima each.*

4. *While the magnetic field, although it does not exceed the Albanian standards, referring to Enel standards in Italy, it in the middle of the camp has values greater than 20 micro tesla.*

5. *As a result of the influence of the ground, because the height of the conductors from the ground is small, the forms of the distribution of the fields in the middle of the camp are more deformed compared to their distribution on the poles.*

9.1 Maximum Electric and Magnetic Field Values in the Middle of the Camp in Uninhabited Areas [40]

The two maxima of the electric field are at the distance $(-6\,m)$ and $(6\,m)$ from the middle of the camp with the same corresponding values of $7.7077\,kV/m$. So, $E_{max} = E_{y_{max}} = 7.7077\,kV/m$. The two maxima of the magnetic field are at the distance $(-6\,m)$ and $(6\,m)$ from the center of the camp with the same corresponding values of 32.5075 micro tesla [41].

The area in which the electric field exceeds the recommended norms includes a 22 m corridor centered in the middle of the camp.

The smallest distance with high intensity of the electric field from the center of the camp is 11 m.

Referring to the standards of Enel in Italy, the area in which the magnetic field exceeds the recommended standards includes a 22 m corridor centered in the middle of the camp.

Referring to Enel standards in Italy, the smallest distance with high intensity of the magnetic field from the middle of the camp is 11 m.

10 Maximum electric & magnetic field values in the middle of the camp in the road areas

The two maxima of the electric field are at the distance $(-6\,m)$ and $(6\,m)$ from the middle of the camp with the same corresponding values of $7.7077 kV/m$. So, $E_{max} = E_{y_{max}} = 7.7077\,kV/m$. The two maxima of the magnetic field are at the distance $(-6m)$ and $(6\,m)$ from the center of the camp with the same corresponding values of 32.5075 micro tesla [42].

The area in which the electric field exceeds the recommended norms includes a 22 m corridor centered in the middle of the camp.

The smallest distance with high intensity of the electric field from the center of the camp is 11 m. Referring to the standards of Enel in Italy, the area in which the magnetic field exceeds the recommended standards includes a 22 m corridor centered in the middle of the camp.

Referring to Enel standards in Italy, the smallest distance with high intensity of the magnetic field from the middle of the camp is 11 m.

11 Maximum electric & magnetic field values in the middle of the camp in the road areas

The two maxima of the electric field are at the distance $(-5\,m)$ and $(5\,m)$ from the middle of the camp with the same corresponding values of 6.2507 kV/m [42]. So, $E_{max} = E_{y_{max}} =$ 6.2507 kV/m. The two maxima of the magnetic field are at the distance $(-5\,m)$ and $(5\,m)$ from the center of the camp with the same corresponding values of 26.3626 micro tesla [43]. Then, $B_{max} = B_{y_{max}} =$ 26.3626 micro tesla.

The area in which the electric field exceeds the recommended norms includes an 18 m corridor centered in the middle of the camp.

The smallest distance with high intensity of the electric field from the center of the camp is 9 m.

Referring to the standards of Enel in Italy, the area in which the magnetic field exceeds the recommended standards includes a 20 m corridor centered in the middle of the camp.

Referring to Enel standards in Italy, the smallest distance with high intensity of the magnetic field from the center of the camp is 10 m.

The maximum values of the electric and magnetic field in the middle of the camp in the residential areas.

The two maxima of the electric field are at the distance $(-6\,m)$ and $(6\,m)$ from the center of the camp with the same corresponding values of 6.8604 kV/m [44]. Therefore, $E_{max} = E_{y_{max}} =$ 6.8604kV/m. The two maxima of the magnetic field are at the distance $(-6\,m)$ and $(6\,m)$ from the center of the camp with the same corresponding values of 28.9340 micro tesla [45]. So, $B_{max} = B_{y_{max}} =$ 28.9340 micro tesla.

The area in which the electric field exceeds the recommended norms includes a 20 m corridor centered in the middle of the camp.

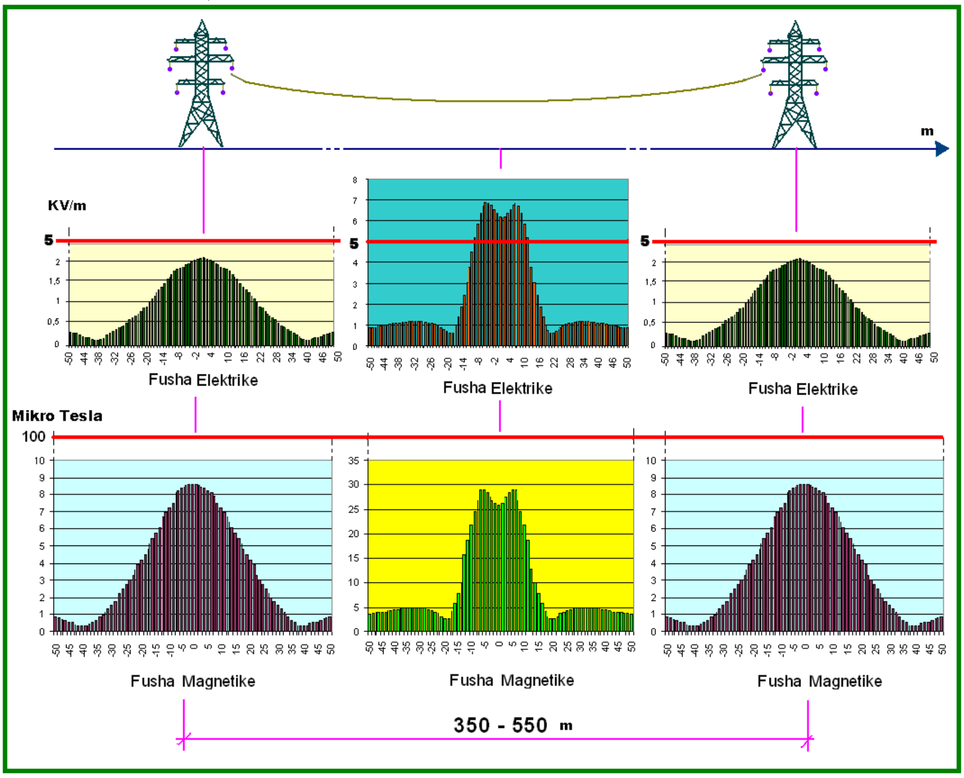
The smallest distance with high intensity of the electric field from the center of the camp is 10 m.

Referring to the standards of Enel in Italy, the area in which the magnetic field exceeds the recommended standards includes a 20 m corridor centered in the middle of the camp.

Referring to Enel standards in Italy, the smallest distance with high intensity of the magnetic field from the center of the camp is 10 m.

The following is a graphical presentation of electric and magnetic fields, specifically at the pole, as well as in the middle of the camp for residential areas.

Figure 9. Graphs of Electric and Magnetic Fields at the Pole and in the Middle of the Camp (for Residential Areas)



Note on the words used in the Figure 9: Fusha Elektrike = Electric Field; Fusha Magnetike = Magnetic Field.

12 Conclusion 3

As can be seen in the photographs above, the conductors of the high voltage lines that are very close to the houses and the people who live in these houses are continuously exposed to the electric and non-magnetic fields. In these areas, the electromagnetic technical conditions have not been respected, and as a result, this exposure of people to the fields in question for a long time can be manifested by the interaction of electrical processes with biological mechanisms. It is more important to mention that living beings are open biological systems, and as a result, people in these areas receive rhythmic information from the surrounding environment that acts in their internal environments. For this reason, measures should be taken to reduce the intensities of the electric and magnetic fields, even though the hypotheses of the impact of the electromagnetic field on the human body have not yet been scientifically proven [46]. Some problems are considered in works [3, 13, 51].

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